(D) REMARKS

Introduction

Paragraph [0035] in the specification is amended to reverse the results of the amendment to paragraph [0035] offered in the response of September 22, 2005 to the first Office Action of June 22, 2005. The current amendment is presented above in section (B) Amendments to the Specification. The paragraph numbers referenced in this response are from the corresponding patent application publication of January 20, 2005 with Pub. No. US 2005/0013194 A1.

Claims 1–42 are pending in the present patent application and all claims are rejected in this Office Action. The Examiner rejects claims 10–15, 22, 39, 41, and 42 under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Further, the Examiner rejects claims 1–42 under 35 U.S.C. §103(a), as still being unpatentable over Robertson *et al.* (U.S. Patent No. US-6,775,618 B1) in view of Harris *et al.* (U.S. Patent No. US-5,150,331 A).

Claims 1, 10, 16, 22, 26, and 33 are amended in this response, while claims 39, 41, and 42 are canceled. A complete set of claims, including amended claims, are presented above in Section (C) Amendments to the Claims.

Claim Rejections – Summary

In the present second Office Action of December 19, 2005, the Examiner states that the arguments offered in applicant's response of September 22, 2005 to the first Office Action of June 22, 2005, are fully considered but not persuasive. The Examiner first states that applicant's arguments with respect to the spatial Fourier transform, and the commensurate amendment of paragraph [0035] of the specification, are not convincing and further considered new matter.

To remove the issue of new matter being added, applicant amends paragraph [0035] of the specification to remove the results of the previous amendment that was offered in the response to the first Office Action. Applicant further amends all five independent claims 1, 10, 16, 26, and 33 to add a limitation equivalent to "transforming the measurements acquired at each of a plurality of source positions by the spatial Fourier transform into the spatial Fourier domain" (for example, in claim 1). The art cited by the Examiner does not utilize the spatial Fourier

transform or the spatial Fourier domain as defined in the present application (and explained in detail below).

Thus, neither Robertson *et al.* ('618) nor Harris *et al.* ('331) teaches or suggests a "method for deghosting and water surface multiple reflection attenuation in dual sensor marine seismic data" that includes "utilizing a spatial Fourier transform to transform data ... into the spatial Fourier domain", as in the present invention, as embodied in independent claim 1, as amended. Similar statements hold for the remaining independent claims 10, 16, 26, and 33, as amended.

The examiner secondly states that the amendment with respect to "independently of knowledge of a source wavelet" and the arguments commensurate are not convincing since Robertson *et al.* ('618) does not specify that the transform utilized is dependent upon source wavelet knowledge. However, the above amendments to all five independent claims 1, 10, 16, 26, and 33 render these independent claims and all their dependent claims allowable.

Claim Rejections: Discussion

In the present second Office Action, the Examiner rejects claims 10–15, 22, 39, 41, and 42 under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. The Examiner states that these claims contain subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time that the application was filed, had possession of the claimed invention.

The Examiner states that the current amendment to paragraph [0035], describing the spatial Fourier transform and its inverse, is not described in the original specification and that there is no reason for one of ordinary skill in this art to believe that the intent of the transform described in the original specification would necessarily be a spatial Fourier transform. The Examiner states that new matter is being added to the specification, in as much as the amendment details a difference between the two transforms (a Fourier transform and the spatial Fourier transform) and details which transform is being utilized (the spatial Fourier transform).

In the response to the first Office Action, applicant amended paragraph [0035] of the specification to clarify that the "spatial Fourier transform" described in the third and fourth

sentence of paragraph [0035] and explicitly defined in Equation (1) was obviously different from the "Fourier transform" mentioned in the first and second sentence of paragraph [0035]. For example, in the second sentence of paragraph [0035], the "Fourier transform" is described as "transforming the data ... from the time-space domain to the spatial frequency domain". The "time-space domain" is the (**x**, t) domain, well-known in the art, where, in the two-dimensional case, $\boldsymbol{x} = (x_1, x_3)$, with x_1 being the horizontal (or lateral) coordinate and x_3 being the vertical (or depth) coordinate. The present application describes data in the two-dimensional "spatial frequency domain" (x_1, x_3, s) for ease of illustration, although the extension to the three-dimensional "spatial frequency domain" (x_1, x_2, x_3, s) is straight forward. The application does not deal with data still in the time-space domain. As noted in the first sentence of paragraph [0032] of the specification, "[t]he actual wavefield is denoted ... in the frequency domain (in which the frequency parameter $s = j\omega$)". Here, the frequency parameter s is the Laplace transform parameter, j is the imaginary number $(-1)^{1/2}$, and ω is angular frequency. Note that the "frequency domain" $(\boldsymbol{x}, s)$ referred to in the first sentence of paragraph [0032] is the same as the "spatial frequency domain", since $\boldsymbol{x} = (x_1, x_3)$. All data considered in the present application has already been transformed, if necessary, into the "spatial frequency domain" (x_1, x_3, s), which typically is accomplished by performing a conventional "Fourier transform".

The "spatial Fourier transform" described in the third and fourth sentences of paragraph [0035] of the specification is explicitly defined in Equation (1) to be a transformation from the "spatial frequency domain" (x_1, x_3, s) into the "spatial Fourier domain" $(js\alpha_1, x_3, s)$, where "α_1 represents the horizontal component of the angular slowness vector" (first sentence of paragraph [0036] of the specification). Note that the spatial Fourier domain parameter $js\alpha_1 = j\,(j\omega)\,(\kappa_1/\omega) = -\kappa_1$, which is, essentially, the horizontal component of the angular wavenumber $\kappa = 2\pi k$, for wavenumber k. Note also that only the horizontal spatial coordinate x_1 is being transformed in the "spatial Fourier transform". The vertical spatial coordinate x_3 is not being transformed into any slowness or wavenumber domain. Equation (2) defines the inverse for the "spatial Fourier transform".

Despite applicant's good intentions in merely clarifying the discussion of the Fourier transforms in the specification, the Examiner states that "in as much as the amendment details a difference between the two transforms and details which transform is being utilized, then there is an issue of new matter being added to the specification". Thus, to remove the unnecessary side

issue of new matter being added, applicant (inverse) amends paragraph [0035] of the specification to remove the results of the previous amendment that was offered in the response to the first Office Action. This current amendment is presented above in section (B) Amendments to the Specification. After these two amendments, paragraph [0035] should read as originally filed.

Nonetheless, with regard to any possibly remaining issue of which Fourier transform applicant is using, the specification as originally filled is still quite clear. The last sentence of paragraph [0035] of the present specification explicitly utilizes the transform name "spatial Fourier Transform" and defines the transform and its inverse in Equations (1) and (2), respectively. The first sentence of paragraph [0037] of the present specification explicitly utilizes the domain name "spatial Fourier domain" in describing which domain the decomposition of the total wavefield into its upgoing and downgoing components takes place in, as given in Equations (4) and (5). Equations (4) and (5) explicitly show that the "spatial Fourier domain" is defined to be $(js\alpha_1, x_3, s)$ and is not the "spatial frequency domain" (x_1, x_3, s) referred to in the second sentence of paragraph [0035] of the specification. Similarly, in the first sentence of paragraph [0063] of the present specification, the name "spatial "Fourier domain" is again utilized and is explicitly shown by accompanying Equation (24) to be the same $(js\alpha_1, x_3, s)$ domain just described. Further, the transform name "spatial Fourier transform" is utilized in the first sentences of paragraphs [0043], [0044], and [0052] of the present specification and is shown by the accompanying Equations (9), (10), and (16), respectively, to be the same transform discussed above, as defined in Equation (1). Equations (9), (10), and (16) also show that this "spatial Fourier transform" transforms data into the same "spatial Fourier domain" $(js\alpha_1, x_3, s)$ as discussed above. Similarly, the transform name "spatial Fourier transform" is again utilized in the second sentence of paragraph [0047] of the present specification to refer to Equation (10), one of the three equations just discussed.

In both the first and the present second Office Actions, the Examiner rejects all claims (1–40 in the first Office Action and 1–42 in the second Office Action) under 35 U.S.C. §103(a), as being unpatentable over Robertson *et al.* ('618), in view of Harris *et al.* ('331). Per independent claims 1, 10, 16, and 26, the Examiner states that Robertson *et al.* ('618) discloses a system, method, and computer program for deghosting and water surface multiple reflection attenuation using pressure and vertical particle motion data. The Examiner states that Robertson

et al. ('618) discloses a spatial filter designed to effectively separate the up-going and down-going wavefield components of the seismic data. The examiner states that the difference between claims 1, 10, 16, and 26 and Robertson *et al.* ('618) is that the decomposition step specified in the claims takes place in the frequency domain and the up-going component is then inverse transformed into the time domain.

The Examiner then states that Harris *et al.* ('331) discloses a method for enhancing seismic data by attenuating noise with a filter. The Examiner states that Harris *et al.* ('331) discloses that typically seismic data is first transformed from the time domain to the frequency domain, filtered (attenuated) in the frequency domain, and then transformed back to the time domain. The Examiner states that it would have been obvious to modify Robertson *et al.* ('618) by combining with Harris *et al.* ('331). Additionally, per independent claim 33, the Examiner states that Robertson *et al.* ('618), at col. 2, lines 48+, discloses the insensitivity of its method to streamer depth, thus allowing the streamer to be towed.

Robertson *et al.* ('618) mentions calculating the vertical wavenumber k_z in the "FK" domain, which is presumably the conventional frequency-wavenumber domain (k_x, k_z, ω) or its equivalent (as depicted in two spatial dimensions). In particular, Robertson *et al.* ('618), in column 6, lines 1–48, specifically refers to the variables k_x, k_y, k_z, and ω. Similarly, Harris *et al.* ('331) describes constructing the dip filter in the "frequency-wavenumber" or "FK" domain, again presumably the (k_1, k_3, ω) domain or its equivalent. In particular, Harris *et al.* ('331), in column 6, lines 1–12, describes transforming the seismic data "from the t-x domain (time, space) to the FK domain employing conventional methods". The domain (k_x, k_z, ω) utilized in both Robertson *et al.* ('618) and Harris *et al.* ('331) is equivalent to (k_1, k_3, ω) or even ($js\alpha_1$, $js\alpha_3$, s). However, this domain (k_x, k_z, ω) is not equivalent to ($js\alpha_1$, x_3, s), which is the "spatial Fourier domain" utilized in the present application. The difference is that in is the "spatial Fourier domain" utilized in the present application, the x_3 spatial coordinate is not Fourier (or otherwise) transformed at all, much less into any wavenumber or slowness coordinate. The "spatial Fourier transform" and the "spatial Fourier domain" defined in the present application are not conventional Fourier transforms and domains, respectively. In particular, the "spatial Fourier transform" and the "spatial Fourier domain" defined in the present application are not utilized in the art cited by the Examiner or other prior art to decompose measured parameters related to pressure and vertical particle motion into upgoing and downgoing wavefield components as part

of a method for deghosting and water surface multiple reflection attenuation in marine seismic data, as in the present application.

In the present response, all five independent claims 1, 10, 16, 26, and 33 are amended. In particular, independent claim 1 is amended to add the limitation "utilizing a spatial Fourier transform to transform data acquired at each of a plurality of source positions into the spatial Fourier domain", along with other minor compatibility changes. Due to this amendment to claim 1, its dependent claims 41 and 42 are now redundant and hence canceled.

Independent claims 16 and 33 are similarly amended. For example, claim 16 now includes the limitation "utilizing a spatial Fourier transform to transform measurements acquired at each of said plurality of source positions into the spatial Fourier domain", along with other minor compatibility changes. Due to this amendment to claim 16, its dependent claim 22 is amended to remove limitations that are now redundant. Similarly, due to this amendment to claim 33, its dependent claim 39 is now redundant and hence canceled.

Independent claim 26 is similarly amended to add the limitation "utilizing a spatial Fourier transform to transform seismic signals acquired at each of a plurality of seismic energy source positions into the spatial Fourier domain", along with other minor compatibility changes. The remaining independent claim 10 is amended analogously to add the limitation "by the spatial Fourier transform" to the element "transforming the data into the spatial Fourier domain".

Now, neither Robertson *et al.* ('618) nor Harris *et al.* ('331) teaches or suggests a "method for deghosting and water surface multiple reflection attenuation in dual sensor marine seismic data" that includes "utilizing a spatial Fourier transform to transform data ... into the spatial Fourier domain", as in the present invention, as embodied in independent claim 1, as amended. Similarly, neither Robertson *et al.* ('618) nor Harris *et al.* ('331) teaches or suggests a "method for deghosting marine seismic data" that includes "transforming the data by the spatial Fourier transform into the spatial Fourier domain" and "separating an upgoing wavefield component of the transformed data in the spatial Fourier domain", as in the present invention, as embodied in independent claim 10. Similarly, neither Robertson *et al.* ('618) nor Harris *et al.* ('331) teaches or suggests a "method for seismic exploration" that includes "utilizing a spatial Fourier transform to transform measurements acquired at each of said plurality of source positions into the spatial Fourier domain", as in the present invention, as embodied in independent claims 16 and 33, as amended. Similarly, neither Robertson *et al.* ('618) nor Harris

et al. ('331) teaches or suggests a "computer program ... containing logic operable to cause a programmable computer to perform steps" that includes "utilizing a spatial Fourier transform to tranform seismic signals ... into the spatial Fourier domain", as in the present invention, as embodied in independent claim 26, as amended.

Further, in the response to the first Office Action, applicant amended independent claims 1, 16, 26, and 33 and dependent claim 40 to add the limitation "independently of knowledge of a source wavelet" to the last element "determining a substantially multiple-free wavefield from the decomposed wavefield components". The Examiner states that amending independent claims 1, 16, 26, and 33 to state that the multiple-free wavefield is determined "independently of knowledge of the source wavelet" does not differentiate over Robertson *et al.* ('618), since Robertson *et al.* ('618) does not specify that the source signature or wavelet forms an integral part of the transformation. However, it has already been shown above that the subject matter of independent claims 1, 10, 16, 26, and 33, as amended, of the present application cannot be derived from either Robertson *et al.* ('618) and Harris *et al.* ('331), alone or in combination, in an obvious way.

The Examiner states that dependent claims 2–9, 11–15, 17–25, 27–32, and 34–40 are further provided for by the above combination of Robertson *et al.* ('618) and Harris *et al.* ('331). However, since independent claims 1, 10, 16, 26, and 33 are allowable, their dependent claims 2–9, 11–15, 17–25, 27–32, and 34–40, respectively, are also allowable. Therefore, applicant believes that all claims, 1–42, as amended, are ready for acceptance.

Applicant recently (March 3, 2006) received a first Examination Report issued by the British Examiner on January 11, 2006 in the British patent application corresponding to the present U.S. patent application. Applicant had previously reported the results of the British Novelty Search Report of September 22, 2004 in a Supplemental Information Disclosure Statement mailed October 11, 2004. In this recent Examination Report, the British Examiner cites a new document, British patent GB 2363459 (Schlumberger Holdings LTD.). However, this cited document is merely the British patent corresponding to one of the U.S. patents, Robertson *et al.* ('618), cited by the U.S. Examiner in the present Office Action (as the British Examiner notes).

Conclusion

Applicant believes that the preceding amendments to the specification and claims place this application in condition for allowance. Applicant respectfully requests the favorable consideration and allowance of this application.

Respectfully submitted,

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